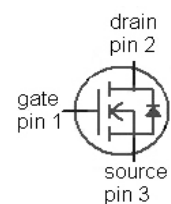
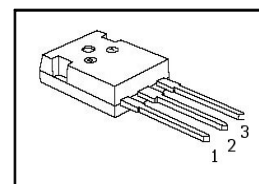


**CoolMOS™ Power Transistor**
**Features**

- New revolutionary high voltage technology
- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme  $dv/dt$  rated
- High peak current capability
- Periodic avalanche rated
- Qualified for industrial grade applications according to JEDEC<sup>1)</sup>
- Pb-free lead plating; RoHS compliant

**Product Summary**

|                  |       |          |
|------------------|-------|----------|
| $V_{DS}$         | 600   | V        |
| $R_{DS(on),max}$ | 0.083 | $\Omega$ |
| $I_D$            | 46    | A        |

**PG-TO247**


| Type        | Package  | Ordering Code | Marking  |
|-------------|----------|---------------|----------|
| SPW47N60CFD | PG-TO247 | Q67045A5051   | 47N60CFD |

**Maximum ratings**, at  $T_j=25\text{ °C}$ , unless otherwise specified

| Parameter                                               | Symbol            | Conditions                                                         | Value       | Unit       |
|---------------------------------------------------------|-------------------|--------------------------------------------------------------------|-------------|------------|
| Continuous drain current                                | $I_D$             | $T_C=25\text{ °C}$                                                 | 46          | A          |
|                                                         |                   | $T_C=100\text{ °C}$                                                | 29          |            |
| Pulsed drain current <sup>1)</sup>                      | $I_{D,pulse}$     | $T_C=25\text{ °C}$                                                 | 115         |            |
| Avalanche energy, single pulse                          | $E_{AS}$          | $I_D=10\text{ A}$ , $V_{DD}=50\text{ V}$                           | 1800        | mJ         |
| Avalanche energy, repetitive $t_{AR}$ <sup>2),3)</sup>  | $E_{AR}$          | $I_D=20\text{ A}$ , $V_{DD}=50\text{ V}$                           | 1           |            |
| Avalanche current, repetitive $t_{AR}$ <sup>2),3)</sup> | $I_{AR}$          |                                                                    | 20          | A          |
| Drain source voltage slope                              | $dv/dt$           | $I_D=46\text{ A}$ , $V_{DS}=480\text{ V}$ ,<br>$T_j=125\text{ °C}$ | 80          | V/ns       |
| Reverse diode $dv/dt$                                   | $dv/dt$           | $I_S=46\text{ A}$ , $V_{DS}=480\text{ V}$ ,<br>$T_j=125\text{ °C}$ | 40          | V/ns       |
| Maximum diode commutation speed                         | $di/dt$           |                                                                    | 600         | A/ $\mu$ s |
| Gate source voltage                                     | $V_{GS}$          | static                                                             | $\pm 20$    | V          |
|                                                         |                   | AC ( $f>1\text{ Hz}$ )                                             | $\pm 30$    |            |
| Power dissipation                                       | $P_{tot}$         | $T_C=25\text{ °C}$                                                 | 417         | W          |
| Operating and storage temperature                       | $T_j$ , $T_{stg}$ |                                                                    | -55 ... 150 | °C         |

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

#### Thermal characteristics

|                                        |            |                                          |   |   |     |     |
|----------------------------------------|------------|------------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case    | $R_{thJC}$ |                                          | - | - | 0.3 | K/W |
| Thermal resistance, junction - ambient | $R_{thJA}$ | leaded                                   | - | - | 62  |     |
| Soldering temperature, wave soldering  | $T_{sold}$ | 1.6 mm (0.063 in.)<br>from case for 10 s | - | - | 260 | °C  |

#### Electrical characteristics, at $T_j=25\text{ °C}$ , unless otherwise specified

#### Static characteristics

|                                  |               |                                                                      |     |      |       |               |
|----------------------------------|---------------|----------------------------------------------------------------------|-----|------|-------|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$                   | 600 | -    | -     | V             |
| Avalanche breakdown voltage      | $V_{(BR)DS}$  | $V_{GS}=0\text{ V}$ , $I_D=46\text{ A}$                              | -   | 700  | -     |               |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=2.9\text{ mA}$                                | 3   | 4    | 5     |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_j=25\text{ °C}$  | -   | 6    | -     | $\mu\text{A}$ |
|                                  |               | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_j=150\text{ °C}$ | -   | 5000 | -     |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                           | -   | -    | 100   | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=29\text{ A}$ ,<br>$T_j=25\text{ °C}$     | -   | 0.07 | 0.083 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=29\text{ A}$ ,<br>$T_j=150\text{ °C}$    | -   | 0.15 | -     |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                        | -   | 0.62 | -     |               |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max}$ ,<br>$I_D=29\text{ A}$                | -   | 30   | -     | S             |

| Parameter | Symbol | Conditions | Values |      |      | Unit |
|-----------|--------|------------|--------|------|------|------|
|           |        |            | min.   | typ. | max. |      |

**Dynamic characteristics**

|                                                            |              |                                                                                       |   |      |   |    |
|------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------|---|------|---|----|
| Input capacitance                                          | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$<br>$f=1\text{ MHz}$                          | - | 7700 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                       | - | 2200 | - |    |
| Reverse transfer capacitance                               | $C_{rss}$    |                                                                                       | - | 77   | - |    |
| Effective output capacitance, energy related <sup>4)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 480 V                                    | - | 245  | - |    |
| Effective output capacitance, time related <sup>5)</sup>   | $C_{o(tr)}$  |                                                                                       | - | 453  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=46\text{ A},$<br>$R_G=3.3\ \Omega$ | - | 30   | - | ns |
| Rise time                                                  | $t_r$        |                                                                                       | - | 30   | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                       | - | 100  | - |    |
| Fall time                                                  | $t_f$        |                                                                                       | - | 15   | - |    |

**Gate Charge Characteristics**

|                       |               |                                                                             |   |     |     |    |
|-----------------------|---------------|-----------------------------------------------------------------------------|---|-----|-----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=480\text{ V}, I_D=46\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 54  | -   | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                             | - | 130 | -   |    |
| Gate charge total     | $Q_g$         |                                                                             | - | 248 | 322 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                             | - | 7.1 | -   | V  |

<sup>1)</sup> J-STD20 and JESD22

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

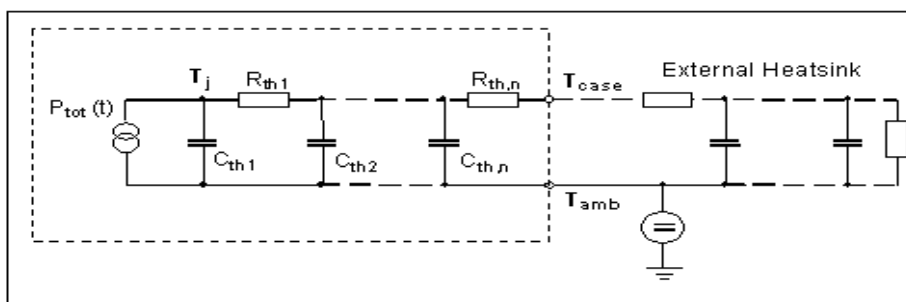
<sup>4)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>5)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

| Parameter                        | Symbol        | Conditions                                                           | Values |      |      | Unit          |
|----------------------------------|---------------|----------------------------------------------------------------------|--------|------|------|---------------|
|                                  |               |                                                                      | min.   | typ. | max. |               |
| Reverse Diode                    |               |                                                                      |        |      |      |               |
| Diode continuous forward current | $I_S$         | $T_C=25\text{ }^{\circ}\text{C}$                                     | -      | -    | 46   | A             |
| Diode pulse current              | $I_{S,pulse}$ |                                                                      | -      | -    | 115  |               |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=46\text{ A}, T_j=25\text{ }^{\circ}\text{C}$ | -      | 1.0  | 1.2  | V             |
| Reverse recovery time            | $t_{rr}$      | $V_R=480\text{ V}, I_F=I_S, di_F/dt=100\text{ A}/\mu\text{s}$        | -      | 210  | -    | ns            |
| Reverse recovery charge          | $Q_{rr}$      |                                                                      | -      | 2    | -    | $\mu\text{C}$ |
| Peak reverse recovery current    | $I_{rrm}$     |                                                                      | -      | 18   | -    | A             |

**Typical Transient Thermal Characteristics**

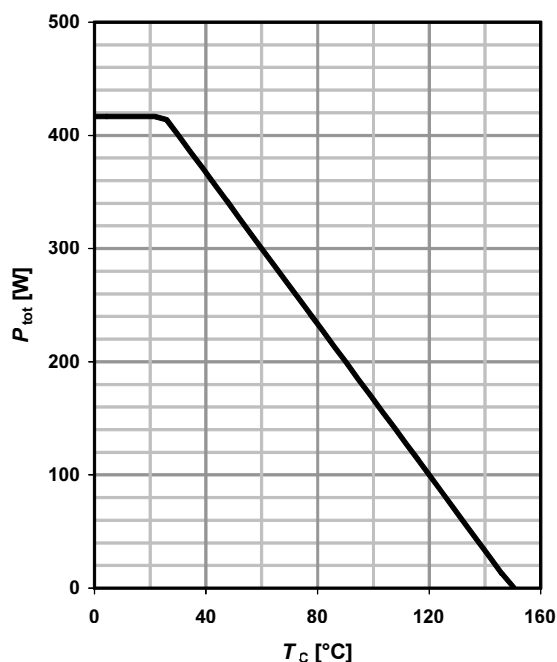
| Symbol    | Value   | Unit | Symbol    | Value             | Unit |
|-----------|---------|------|-----------|-------------------|------|
|           | typ.    |      |           | typ.              |      |
| $R_{th1}$ | 0.00289 | K/W  | $C_{th1}$ | 0.000564          | Ws/K |
| $R_{th2}$ | 0.00399 |      | $C_{th2}$ | 0.0034            |      |
| $R_{th3}$ | 0.0224  |      | $C_{th3}$ | 0.0048            |      |
| $R_{th4}$ | 0.0421  |      | $C_{th4}$ | 0.0273            |      |
| $R_{th5}$ | 0.0619  |      | $C_{th5}$ | 0.149             |      |
|           |         |      | $C_{th6}$ | 4.4 <sup>5)</sup> |      |



<sup>5)</sup>  $C_{th6}$  models the additional heat capacitance of the package in case of non-ideal cooling. It is not needed if  $R_{thCA}=0\text{ K/W}$ .

## 1 Power dissipation

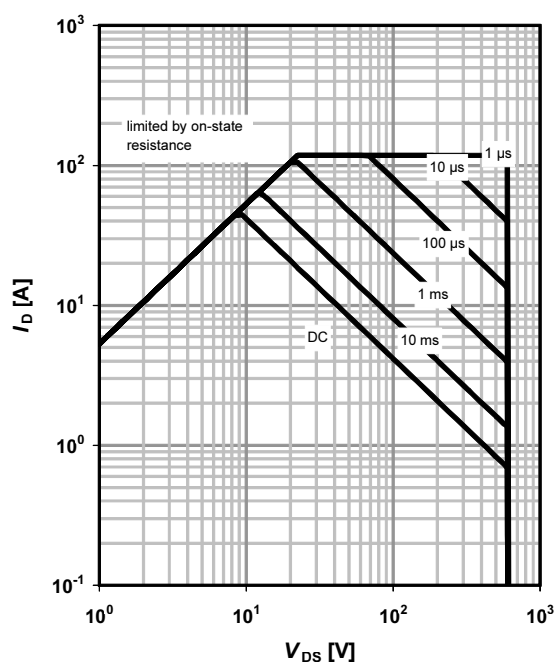
$$P_{\text{tot}} = f(T_C)$$



## 2 Safe operating area

$$I_D = f(V_{DS}); T_C = 25^\circ\text{C}; D = 0$$

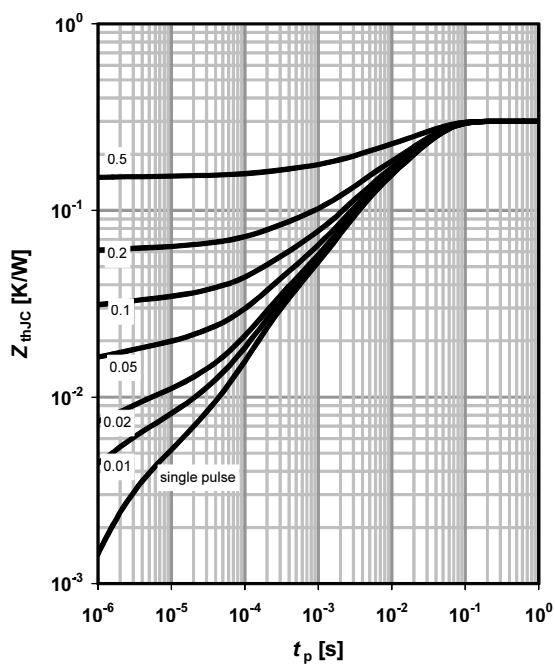
parameter:  $t_p$



## 3 Max. transient thermal impedance

$$I_D = f(V_{DS}); T_J = 25^\circ\text{C}$$

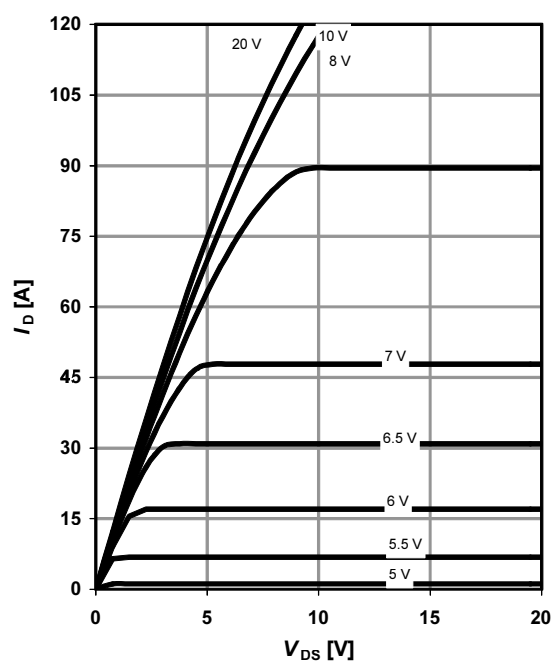
parameter:  $D = t_p / T$



## 4 Typ. output characteristics

$$I_D = f(V_{DS}); T_J = 25^\circ\text{C}$$

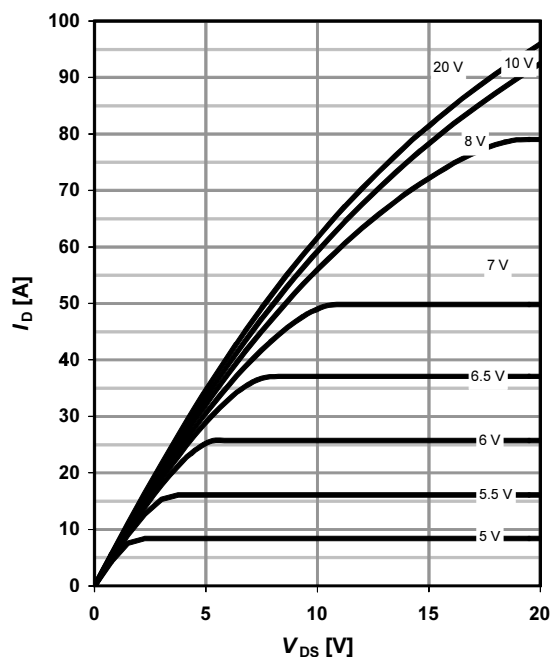
parameter:  $V_{GS}$



### 5 Typ. output characteristics

$$I_D = f(V_{DS}); T_j = 150^\circ\text{C}$$

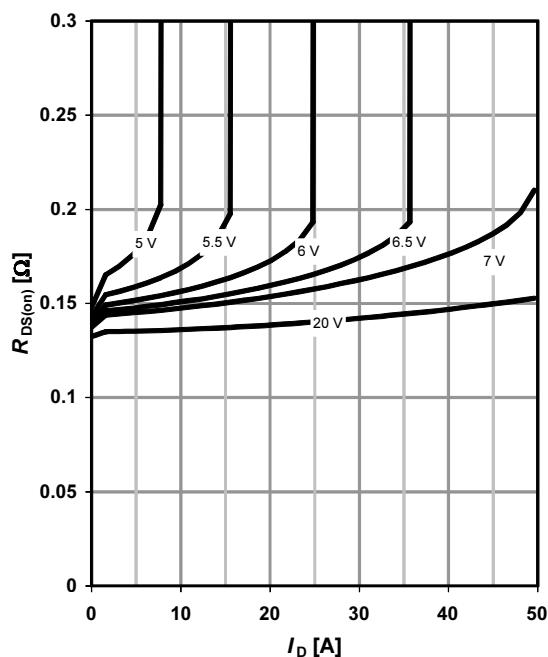
parameter:  $V_{GS}$



### 6 Typ. drain-source on-state resistance

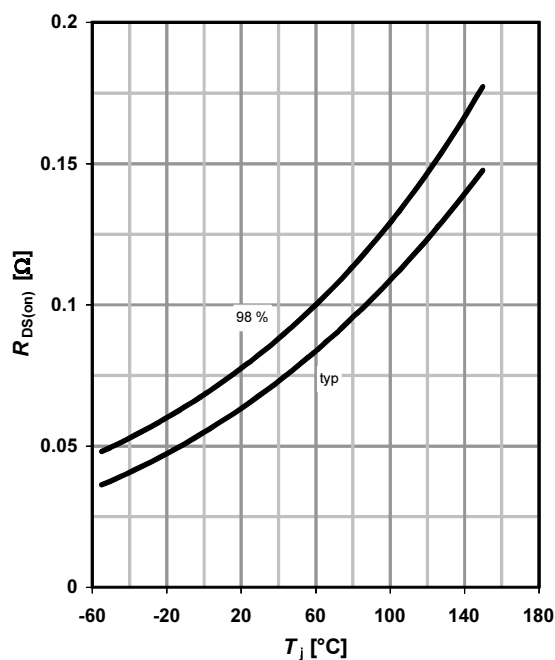
$$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$$

parameter:  $V_{GS}$



### 7 Drain-source on-state resistance

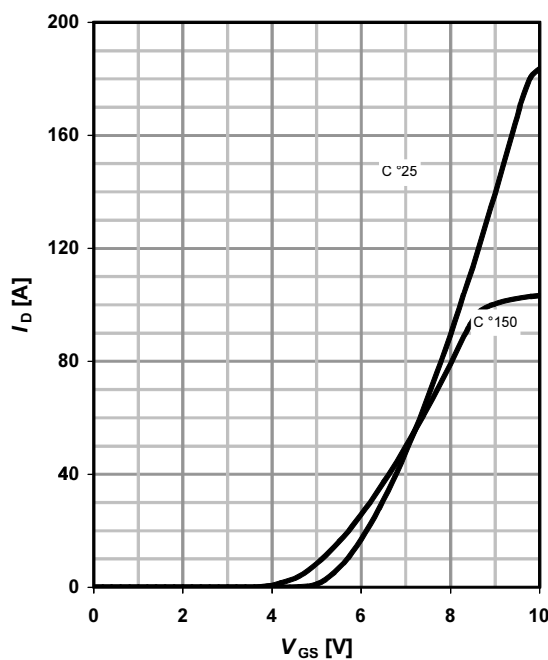
$$R_{DS(on)} = f(T_j); I_D = 30\text{ A}; V_{GS} = 10\text{ V}$$



### 8 Typ. transfer characteristics

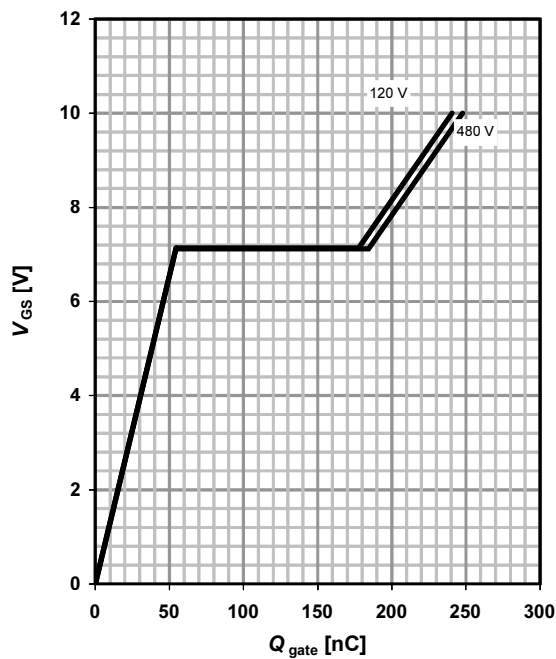
$$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)\max}$$

parameter:  $T_j$



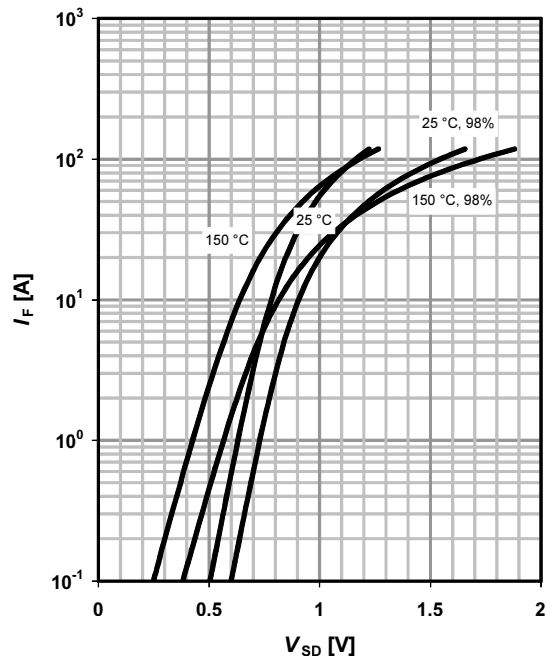
### 9 Typ. gate charge

 $V_{GS}=f(Q_{gate}); I_D=47\text{ A pulsed}$ 

parameter:  $V_{DD}$ 


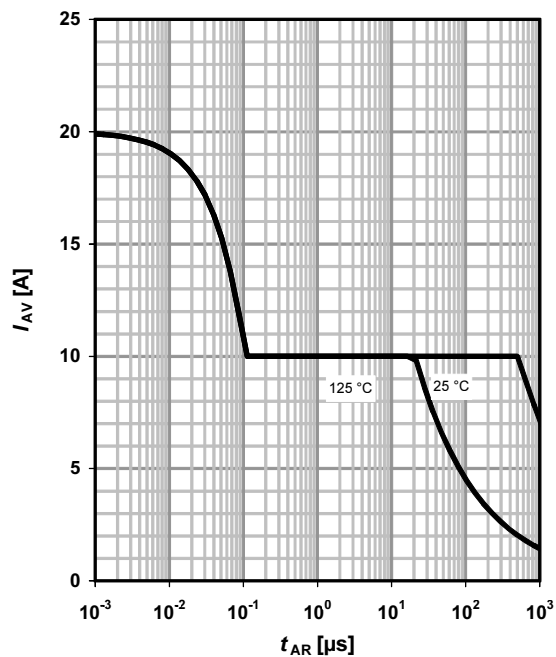
### 10 Forward characteristics of reverse diode

 $I_F=f(V_{SD})$ 

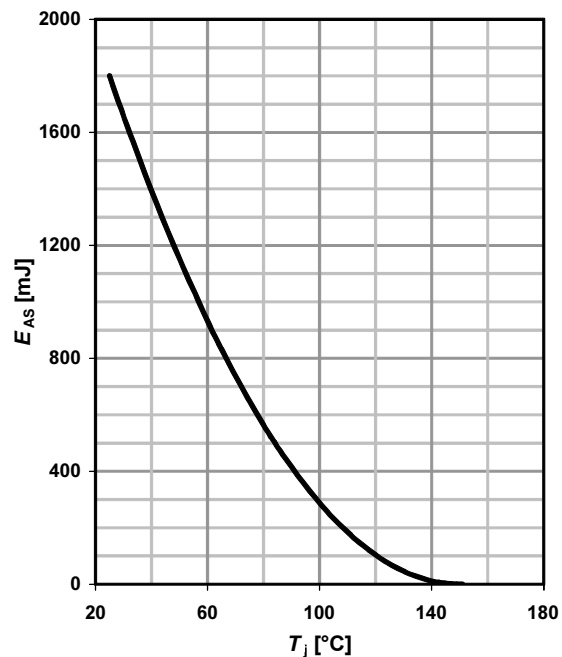
parameter:  $T_j$ 


### 11 Avalanche SOA

 $I_{AR}=f(t_{AR})$ 

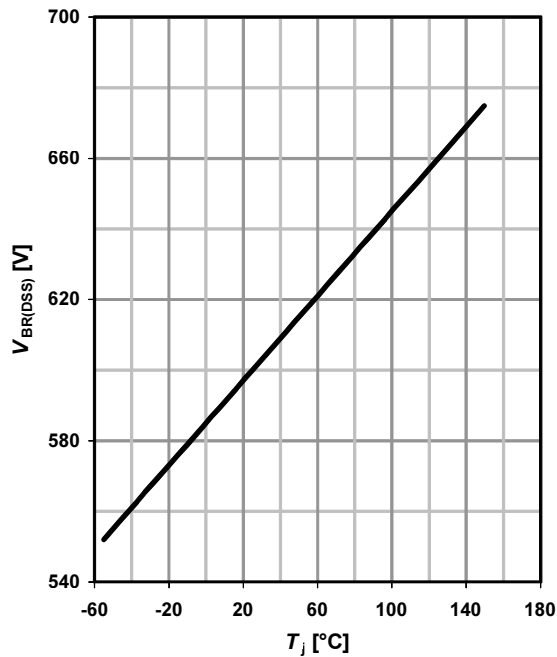
parameter:  $T_{j(start)}$ 


### 12 Avalanche energy

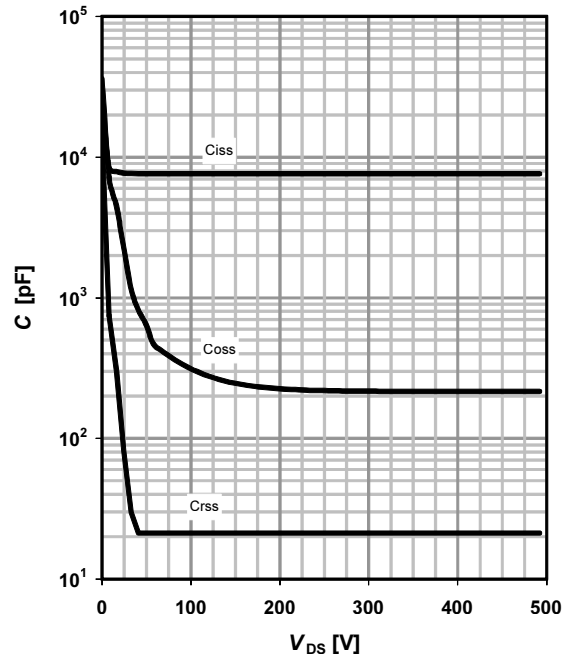
 $E_{AS}=f(T_j); I_D=10\text{ A}; V_{DD}=50\text{ V}$ 


**13 Drain-source breakdown voltage**

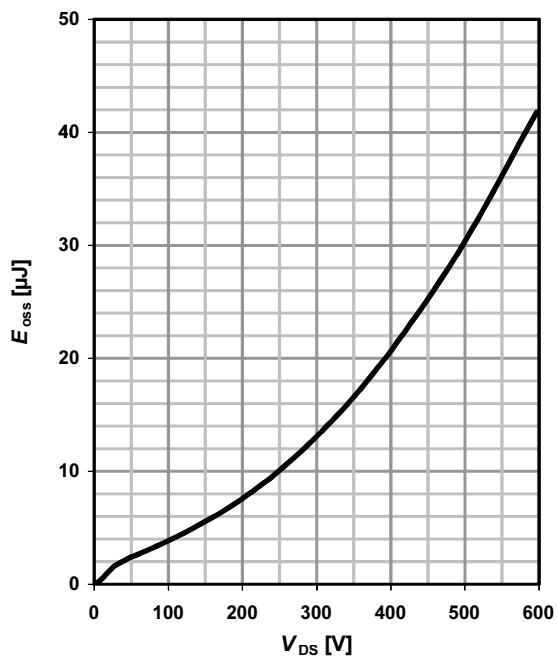
$$V_{BR(DSS)} = f(T_j); I_D = 15 \text{ mA}$$


**14 Typ. capacitances**

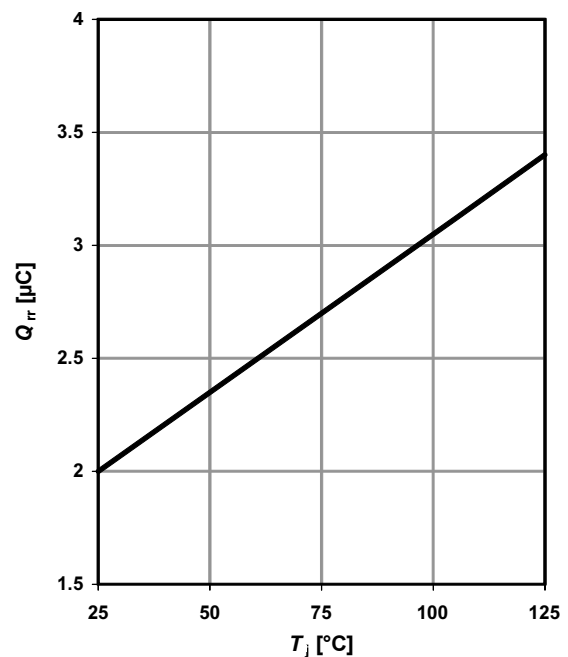
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$


**15 Typ.  $C_{oss}$  stored energy**

$$E_{oss} = f(V_{DS})$$


**16 Typ. reverse recovery charge**

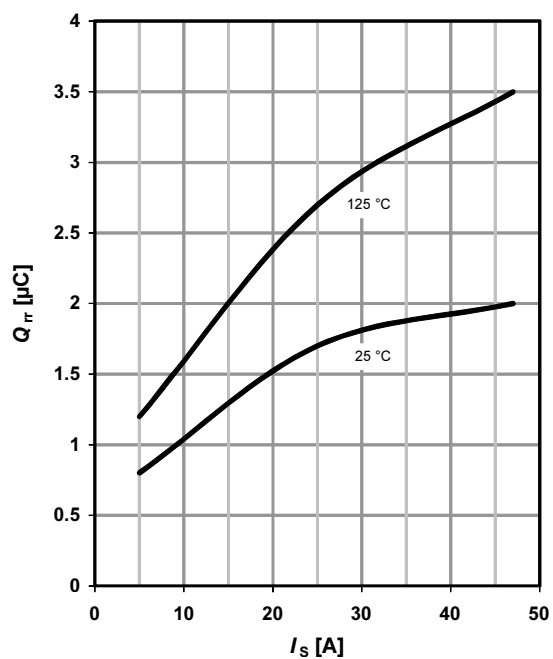
$$Q_{rr} = f(T_j); I_S = 47 \text{ A}; di/dt = 100 \text{ A/μs}$$



### 17 Typ. reverse recovery charge

$$Q_{rr} = f(I_S); di/dt = 100 \text{ A}/\mu\text{s}$$

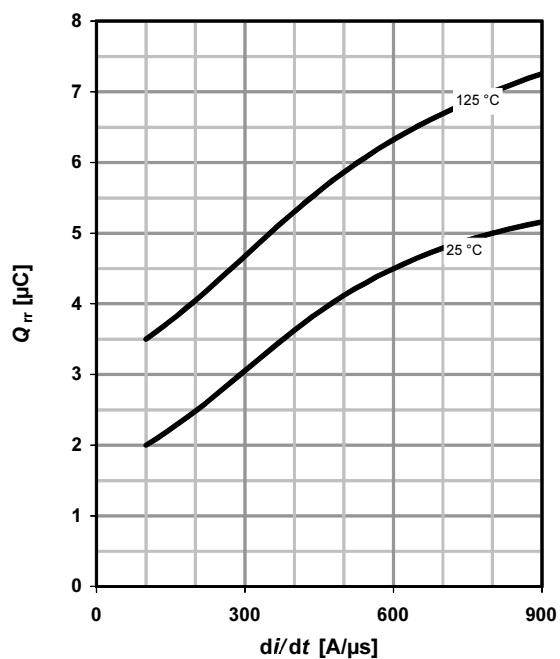
parameter:  $T_j$

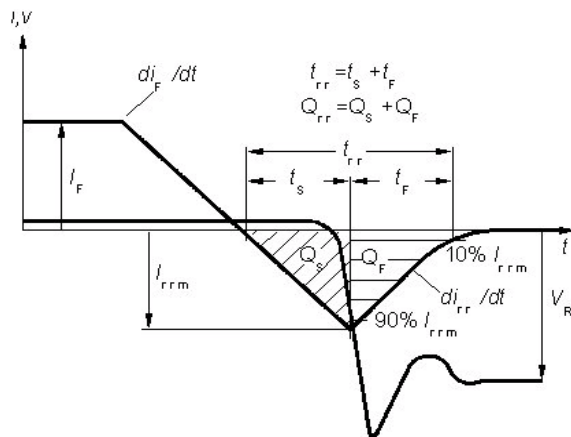


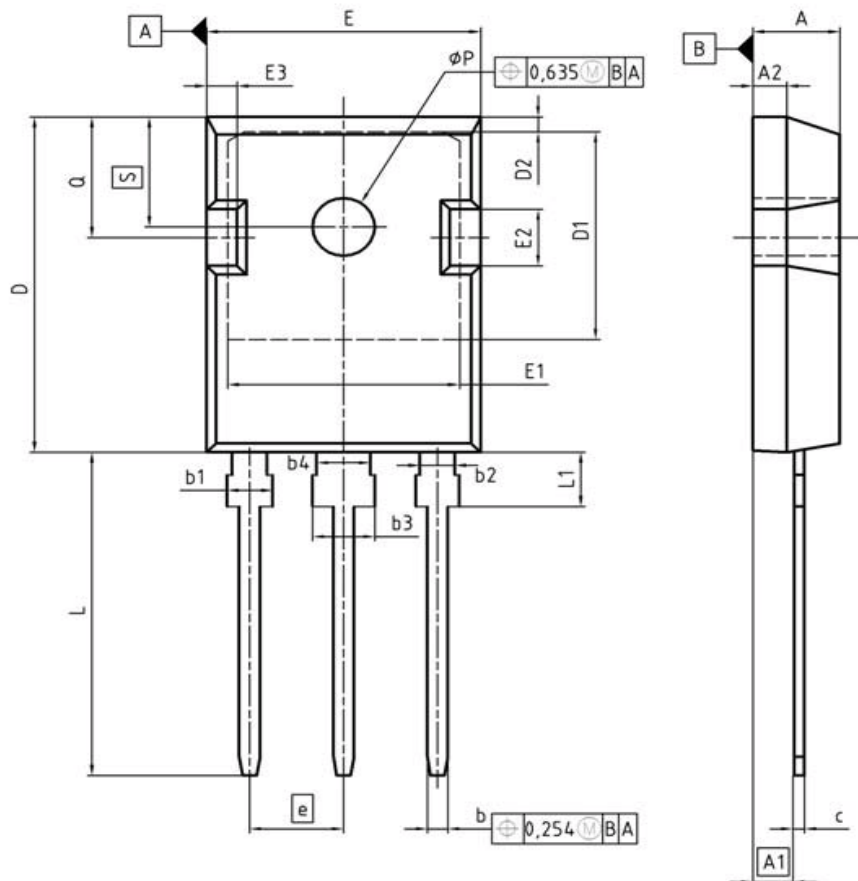
### 18 Typ. reverse recovery charge

$$Q_{rr} = f(di/dt); I_S = 47 \text{ A}$$

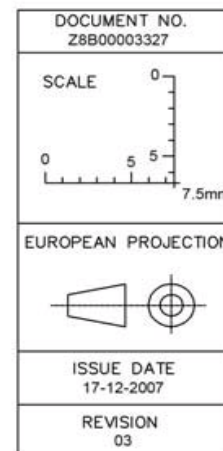
parameter:  $T_j$



**Definition of diode switching characteristics**




| DIM      | MILLIMETERS |       | INCHES |       |
|----------|-------------|-------|--------|-------|
|          | MIN         | MAX   | MIN    | MAX   |
| A        | 4.90        | 5.16  | 0.193  | 0.203 |
| A1       | 2.27        | 2.53  | 0.089  | 0.099 |
| A2       | 1.85        | 2.11  | 0.073  | 0.083 |
| b        | 1.07        | 1.33  | 0.042  | 0.052 |
| b1       | 1.90        | 2.41  | 0.075  | 0.095 |
| b2       | 1.90        | 2.16  | 0.075  | 0.085 |
| b3       | 2.87        | 3.38  | 0.113  | 0.133 |
| b4       | 2.87        | 3.13  | 0.113  | 0.123 |
| c        | 0.55        | 0.68  | 0.022  | 0.027 |
| D        | 20.82       | 21.10 | 0.820  | 0.831 |
| D1       | 16.25       | 17.65 | 0.640  | 0.695 |
| D2       | 1.05        | 1.35  | 0.041  | 0.053 |
| E        | 15.70       | 16.03 | 0.618  | 0.631 |
| E1       | 13.10       | 14.15 | 0.516  | 0.557 |
| E2       | 3.68        | 5.10  | 0.145  | 0.201 |
| E3       | 1.68        | 2.60  | 0.066  | 0.102 |
| e        | 5.44        |       | 0.214  |       |
| N        | 3           |       | 3      |       |
| L        | 19.80       | 20.31 | 0.780  | 0.799 |
| L1       | 4.17        | 4.47  | 0.164  | 0.176 |
| $\phi P$ | 3.50        | 3.70  | 0.138  | 0.146 |
| Q        | 5.49        | 6.00  | 0.216  | 0.236 |
| S        | 6.04        | 6.30  | 0.238  | 0.248 |



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## 1 New package outlines TO-247

Assembly capacity extension for CoolMOSTM technology products assembled in lead-free package  
PG-TO247-3 at subcontractor ASE (Weihai) Inc., China (Changes are marked in blue.)

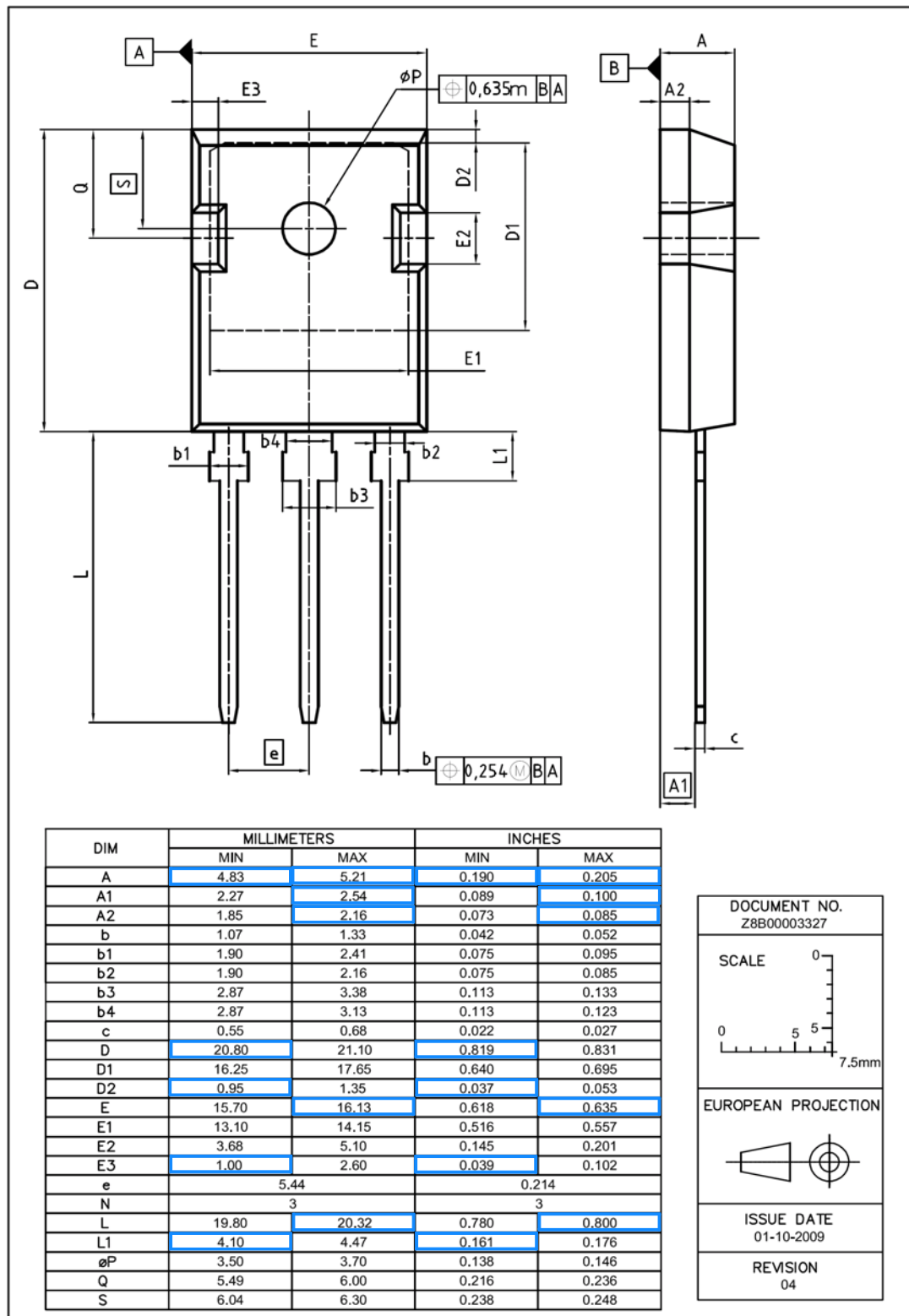


Figure 1 Outlines TO-247, dimensions in mm/inches